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June 2001



Biology 30
Grade 12 Diploma Examination

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June 2001

Biology 30

Grade 12 Diploma Examination

Description

Time: This examination was developed to be completed in 2.5 h; however, you may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, of equal value, worth 30% of the examination

This exam contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

Tear-out data pages are included near the back of this booklet.

Note: *The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.*

Instructions

- You are expected to provide your own calculator. You may use any scientific calculator or a graphing calculator approved by Alberta Learning. **NEW**
- You are expected to have cleared your calculator of all information that is stored in the programmable or parametric memory. **NEW**
- Use only an HB pencil for the machine-scored answer sheet.
- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- Read each question carefully.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- If you wish to change an answer, erase **all** traces of your first answer.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Learning.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

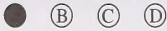
- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A. biology
- B. physics
- C. science
- D. chemistry

Answer Sheet



Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Round and record your **answer to one decimal place** in the numerical-response section on the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666\dots \\ &= 23.7 \text{ (rounded to one decimal place)}\end{aligned}$$

Record 23.7 on the answer sheet →

2	3	.	7
---	---	---	---

●	●		
(0)	(0)	(0)	(0)
(1)	(1)	(1)	(1)
●	(2)	(2)	(2)
(3)	●	(3)	(3)
(4)	(4)	(4)	(4)
(5)	(5)	(5)	(5)
(6)	(6)	(6)	(6)
(7)	(7)	(7)	●
(8)	(8)	(8)	(8)
(9)	(9)	(9)	(9)

Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

Record 3214 on the answer sheet →

3	2	1	4
•	•		
0	0	0	0
1	1	•	1
2	•	2	2
•	3	3	3
4	4	4	•
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Selection Question and Solution

The birds in the following list are numbered _____.

(Record your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

- 1 dog
- 2 sparrow
- 3 cat
- 4 robin
- 5 chicken

Answer 245

Record 245 on the answer sheet →


2	4	5
•	•	
0	0	0
1	1	1
•	2	2
3	3	3
4	•	4
5	5	•
6	6	6
7	7	7
8	8	8
9	9	9

Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must address **all** aspects of the question.
- Descriptions and/or explanations of concepts must be correct and include pertinent ideas, diagrams, calculations, and formulas.
- Your answers must be presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.

Additional Instructions for Students Using Word Processors

- Keep all work together. Diagrams, graphs, calculations, etc. should be placed directly on your word-processed pages.
- Staple your final printed work to the page indicated for each word-processed response.
- Indicate in the space provided on the back cover that you attached word-processed pages.



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Use the following information to answer the first two questions.

Between seven and 12 months of age, infants begin to display a marked fear of strangers. Infants also begin to socially reference their responses during the same period. Some research indicates that extremely fearful children often have very anxious parents.

1. The division of the nervous system that is directly responsible for physiological responses to fear is the
 - A. sensory nervous system
 - B. somatic nervous system
 - C. sympathetic nervous system
 - D. parasympathetic nervous system

Use the following additional information to answer the next question.

Biofeedback consists of conscious efforts to control body responses that are normally involuntary. This technique can be used to control abnormal fear.

2. Conscious efforts to control body responses through biofeedback originate in the
 - A. medulla
 - B. cerebrum
 - C. cerebellum
 - D. hypothalamus

Use the following information to answer the next four questions.

Parkinson's disease is a degenerative brain disorder. Symptoms of the disease include tremors, rigid muscles, and problems with coordinated movements such as walking and talking. Researchers have discovered that in people with Parkinson's disease, the neurons that produce dopamine, a neurotransmitter in the brain, have died. Based on this research, a number of potential treatments for the disease are being tested. Three of these treatments are explained below.

1. In one treatment, fetal pig brain cells that produce dopamine were used. After cloning these cells, the cloned cells were injected into 11 people with Parkinson's disease. Most of the people showed some improvement in their symptoms during the following year.
2. Levodopa is a drug that replaces missing dopamine. Unfortunately, in large doses, it has severe side effects, including nausea and heart problems.
3. A new drug called seligiline acts as an inhibitor of the enzyme monoamine oxidase B, which breaks down dopamine.

—from Henahan, 1998

3. During the cloning of a fetal pig's brain cells, the cells underwent the process of i, which increased their numbers, and after injection into people with Parkinson's disease, the cells produced dopamine when the ii code for it was translated.

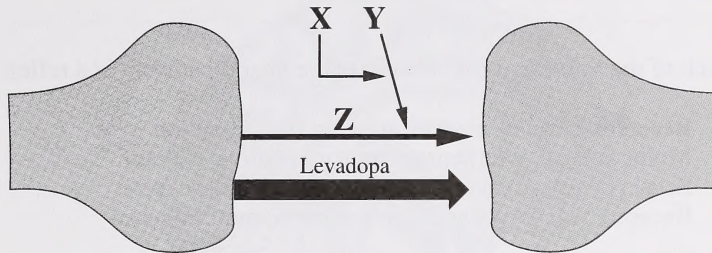
The row that completes the statement above is row

Row	<i>i</i>	<i>ii</i>
A.	meiosis	DNA
B.	meiosis	mRNA
C.	mitosis	DNA
D.	mitosis	mRNA

4. The drugs levodopa and seligiline are similar in that they both
- A. require cloning
 - B. act as inhibitors
 - C. prevent the death of neurons
 - D. increase neurotransmission in the brain

Use the following additional information to answer the next question.

Schematic Diagram of the Actions of Levadopa, Dopamine, Seligiline, and Monoamine Oxidase B in a Neural Synapse



5. Which of the following rows correctly identifies the substances that correspond to X, Y, and Z in the diagram above?

Row	Dopamine	Seligiline	Monoamine Oxidase B
A.	X	Y	Z
B.	Z	X	Y
C.	Z	Y	X
D.	X	Z	Y

Use the following additional information to answer the next question.

People affected by Parkinson's disease have unusually low levels of the neurotransmitter dopamine. Studies have shown that the risk of developing Parkinson's disease is about double for non-smokers than for smokers. Brain scans of smokers and non-smokers reveal that levels of the enzyme monoamine oxidase B(MAOB) are about 40% lower in smokers than in non-smokers. MAOB is one of the enzymes involved in breaking down dopamine.

6. A possible reason for the link between smoking and a reduced risk of developing Parkinson's disease is that smoking
- reduces the level of dopamine and MAOB
 - increases the level of dopamine and MAOB
 - reduces the level of dopamine by increasing the level of MAOB
 - increases the level of dopamine by decreasing the level of MAOB

Use the following information to answer the next question.

Individuals know that touching a hot stove can be painful. When an individual accidentally touches a hot stove, a reflex arc is initiated, which causes the person to withdraw his or her hand before he or she senses the pain.

7. Which of the following lists identifies the neural pathway in a reflex arc?
- A. Receptor, sensory neuron, effector, motor neuron
 - B. Motor neuron, interneuron, sensory neuron, effector
 - C. Sensory neuron, receptor, interneuron, motor neuron
 - D. Receptor, sensory neuron, interneuron, motor neuron

Use the following information to answer the next question.

Alternative medicine, such as aromatherapy, is becoming increasingly popular in western society. Aromatherapy uses natural oils and plant extracts. The scents of the oils and extracts are inhaled or the fragrant oils are massaged into the skin. Proponents of aromatherapy hypothesize that odours affect the brain and its release of neurochemicals. These neurochemicals may then relieve pain.

Hypothesized Steps in Aromatherapy Action

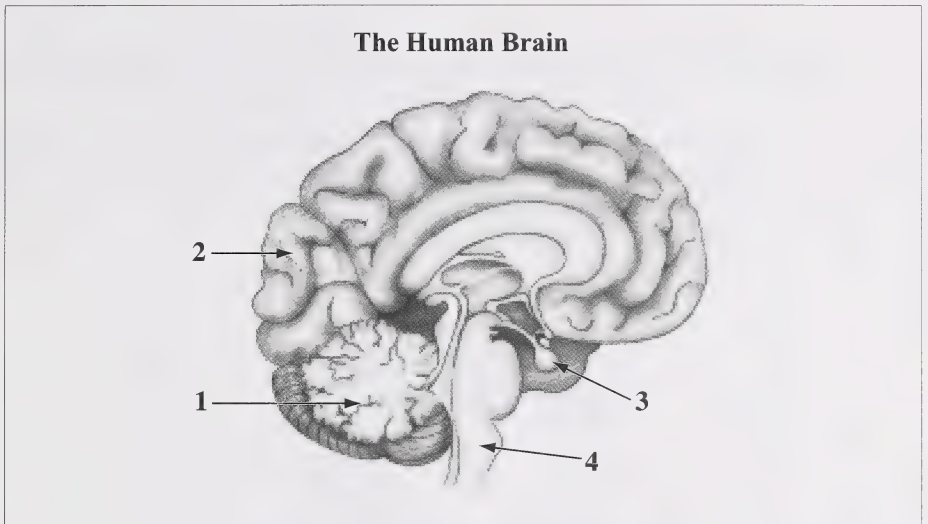
- 1 Olfactory neurons depolarize.
- 2 Olfactory receptors are stimulated.
- 3 Neurochemicals affect pain interpretation.
- 4 Neurochemicals are released from axon terminals.

Numerical Response

1. If it is assumed that the hypothesis is correct, the order in which the steps above would occur to result in pain relief in a person having just inhaled the scent from an aromatherapy oil or extract is _____, _____, _____, and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.



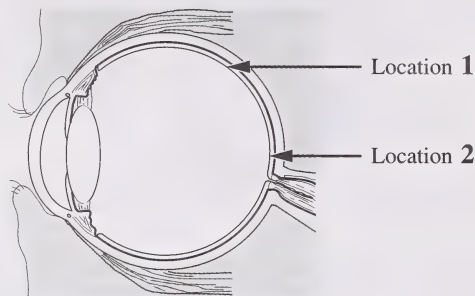
8. The area of the brain that controls the sympathetic and parasympathetic nervous systems is labelled
- A. 1
 - B. 2
 - C. 3
 - D. 4

Use the following information to answer the next four questions.

Erectile dysfunction is defined as the inability to maintain an erection adequate enough to achieve a satisfactory sexual experience. When erectile dysfunction is related to inadequate blood flow to the penis, the medication Viagra can be prescribed.

A side effect of Viagra is that it sometimes results in temporary difficulties in distinguishing between the colours of blue and green. For this reason, pilots have been banned from using the drug within six hours of a flight.

The Human Eye



9. The cells in the eye that are affected by Viagra and the primary location of these cells, as labelled above, are, respectively,
- A. rod cells and location 1
 - B. rod cells and location 2
 - C. cone cells and location 1
 - D. cone cells and location 2

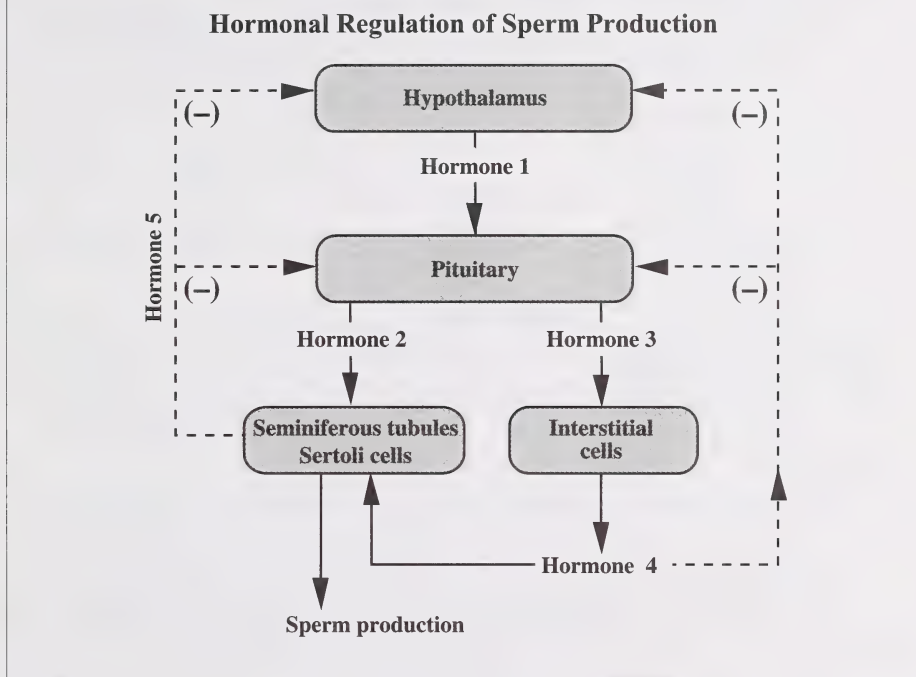
Use the following additional information to answer the next question.

A chemical in the body known as cyclic GMP initiates the muscular and vascular changes that lead to an erection. Receptors for cyclic GMP are found in erectile tissue. Normally, the enzyme PDE5 breaks down cyclic GMP. Viagra blocks the action of this enzyme.

10. Viagra could be prescribed to treat impotence in males with
- A. normal levels of GMP but low levels of PDE5
 - B. low levels of GMP but normal levels of PDE5
 - C. high levels of GMP but normal levels of GMP receptors
 - D. normal levels of GMP but high levels of GMP receptors

Use the following additional information to answer the next two questions.

Erectile dysfunction can result in the inability of a couple to conceive. However, infertility is more commonly associated with insufficient sperm production. The feedback loop below illustrates the hormonal control of sperm production.

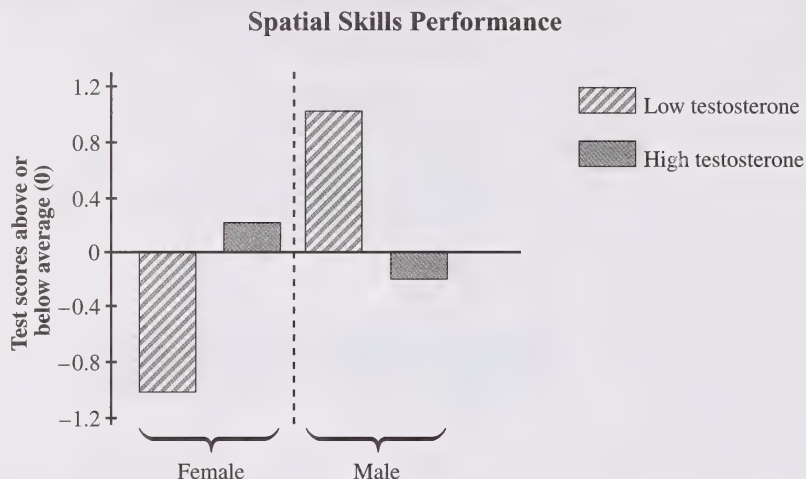


11. In the diagram above, the hormones FSH, LH, and testosterone are labelled, respectively,
 - A. 2, 3, 4
 - B. 2, 3, 5
 - C. 3, 2, 4
 - D. 3, 2, 5

12. If infertility were due to decreased production of hormone 1 by the hypothalamus, then fewer sperm would be produced because there would be
 - A. low levels of hormone 2
 - B. high levels of hormone 3
 - C. high levels of hormone 4
 - D. low levels of hormone 5

Use the following information to answer the next four questions.

Sex-based differences in mental ability are controversial subjects of research. An article by Doreen Kimura in *Scientific American* summarized some of the studies conducted in this area. One study was carried out to compare males' and females' performance on a variety of mental tasks. The males and females in the study had either relatively low testosterone or relatively high testosterone levels. (Females produce small amounts of testosterone in the adrenal cortex.) Results for the spatial skills component of the study are provided below.



—Graph and excerpt adapted from *Sex Differences in the Brain* by Doreen Kimura. Copyright © 1992 by Scientific American Inc. All rights reserved.

13. Two manipulated variables in this study are
- sex and spatial skills
 - test scores and spatial skills
 - sex and testosterone levels
 - test scores and testosterone levels
14. Based on the results shown in the graph above, the effect that administering extra testosterone to females and males will have on their respective spatial skills is shown in row

Row	Females	Males
A.	improved	improved
B.	weakened	improved
C.	improved	weakened
D.	weakened	weakened

15. The cells that produce testosterone in females and in males are given in row

Row	Females	Males
A.	follicle cells	interstitial cells
B.	adrenal cortex cells	interstitial cells
C.	follicle cells	seminiferous tubule cells
D.	adrenal cortex cells	seminiferous tubule cells

Use the following additional information to answer the next question.

Researchers have found evidence that during the part of the menstrual cycle in which a woman's estrogen level is highest, her spatial skills are weakest while her motor skills and articulation skills are enhanced. Another study summarized by Kimura measured testosterone levels in saliva. The study found that relatively low testosterone levels in males enhanced their mathematical reasoning, but there was no correlation between testosterone levels and a woman's mathematical reasoning ability.

—from Kimura, 1992

Statements Related to Womens' Hormonal Levels and Skill Levels

- 1 Increased testosterone and increased estrogen increase a woman's spatial skills.
- 2 Increased testosterone and decreased estrogen increase a woman's spatial skills.
- 3 During pregnancy, a woman's spatial skills are enhanced.
- 4 During pregnancy, a woman's motor skills are enhanced.
- 5 During pregnancy, a woman's articulation skills are reduced.
- 6 A woman's spatial skills are enhanced around day 1 of her menstrual cycle.
- 7 A woman's motor skills are enhanced around day 14 of her menstrual cycle.
- 8 A woman's mathematical skills are enhanced around day 14 of her menstrual cycle.

Numerical Response

2. This research supports the **four** statements numbered _____, _____, _____, and _____.

(Record your **four-digit answer from lowest to highest numeric order** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

Research performed on *Drosophila* has revealed the presence of genes that code for products that influence learning. Researchers have isolated a *dunce* gene known to code for an enzyme involved with learning. Flies with a mutated form of the gene cannot learn to associate between a specific odour and an electric shock. Flies with normal genes can learn the association. Although the enzyme is prevalent throughout the nervous system, it is concentrated in structures in the brain that are involved in learning and memory.

—from Levine and Suzuki, 1993

16. The concept that is **most strongly** supported by this discovery is that
- A. genes are involved in enzyme production that influences learning
 - B. genes are involved in enzyme production that controls stimuli creation
 - C. learning is a wholly inherited trait and is not influenced by the environment
 - D. learning is not an inherited trait and is wholly influenced by the environment

Use the following information to answer the next two questions.

Alpha reductase type II is an enzyme that converts the hormone testosterone into dihydroxytestosterone (DHT). A variation in the allele that codes for the enzyme results in a single amino acid change: a valine replaces a leucine. The enzyme that contains valine instead of leucine is more efficient and results in the production of more DHT. DHT may increase the susceptibility of prostate cells to cancer.

—from Travis, 1996

17. The incidence of prostate cancer is likely highest in men who are
- A. homozygous for the normal allele
 - B. homozygous for the allele variation
 - C. heterozygous, because these men produce both versions of the enzyme
 - D. heterozygous, because these men produce neither version of the enzyme
18. Possible DNA triplets for valine and leucine are identified in row

Row	Valine	Leucine
A.	CAT	GTG
B.	CAA	GAA
C.	GTT	CTT
D.	GUU	CUC

Use the following information to answer the next two questions.

One cause of reduced fertility in males may be related to azoospermia. Males with this condition are not completely sterile but produce low numbers of sperm, which results in reduced fertility. The gene *DAZ* located on the Y chromosome may be vital to spermatogenesis. Deletion of this gene by mutation may lead to infertility, even if the rest of the Y chromosome is intact. In a particular study, tissue samples from a male with azoospermia revealed the lack of the *DAZ* gene in blood cells and in sperm.

—from Travis, 1996

19. Which of the following pieces of evidence would indicate that the male examined in this study did not experience a genetic mutation in his gonadal cells but **more likely** inherited the condition?
- A. Azoospermia is found in 3% to 4% of males.
 - B. The *DAZ* gene once deleted can never be regained.
 - C. Deletion of the *DAZ* gene occurs more commonly during meiosis.
 - D. Both blood cells and sperm of the subject were lacking the *DAZ* gene.
20. If a male with azoospermia were to father sons through *in vitro* fertilization, what percentage of his sons would be expected to have azoospermia?
- A. 0%
 - B. 25%
 - C. 50%
 - D. 100%

Use the following information to answer the next three questions.

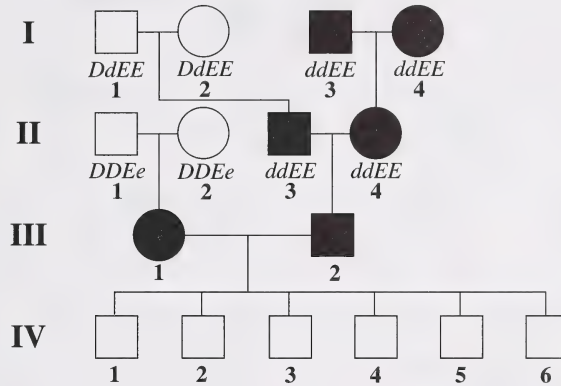
Ideas concerning the nature of inheritance have very early origins, but the conceptual breakthrough that established modern genetics as a science was made less than 150 years ago by an Austrian monk, Gregor Mendel.

21. Alternate forms of the same gene are known as
- A. alleles
 - B. gametes
 - C. genotypes
 - D. heterozygotes
22. Mendel's principle of segregation states that alternate forms of a gene separate during
- A. fertilization
 - B. seed dispersal
 - C. cross-pollination
 - D. gamete formation
23. An organism is heterozygous for two pairs of genes. The number of different combinations of alleles that can form for these two genes in the organism's gametes is
- A. 1
 - B. 2
 - C. 4
 - D. 8

Use the following information to answer the next three questions.

Deaf-mutism is an autosomal recessive trait that is caused by two genes. Individuals who are homozygous recessive for either gene will have deaf-mutism. The two genes are designated as *D* and *E* in the diagram below.

Partial Pedigree for Deaf-Mutism



—from Huskey, 1998

24. A possible genotype of individual IV-3 is
- ddEE*
 - ddEe*
 - DDEe*
 - DdEe*
25. Individuals III-1 and III-2 are expecting their seventh child. What is the probability of this child having deaf-mutism?
- 0.00
 - 0.25
 - 0.50
 - 0.75

Numerical Response

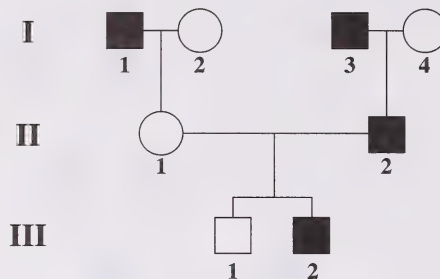
3. What is the probability of a couple that are heterozygous for both genes having a child with deaf-mutism?

Answer: _____

(Record your answer as a value from 0 to 1, rounded to two decimal places, in the numerical-response section on the answer sheet.)

Use the following information to answer the next three questions.

In the hypothetical pedigree below, shaded individuals have sickle cell anemia and are homozygous for the defective allele Hb^S . The normal allele is Hb^A . Carriers of the Hb^S allele are not identified in the pedigree.



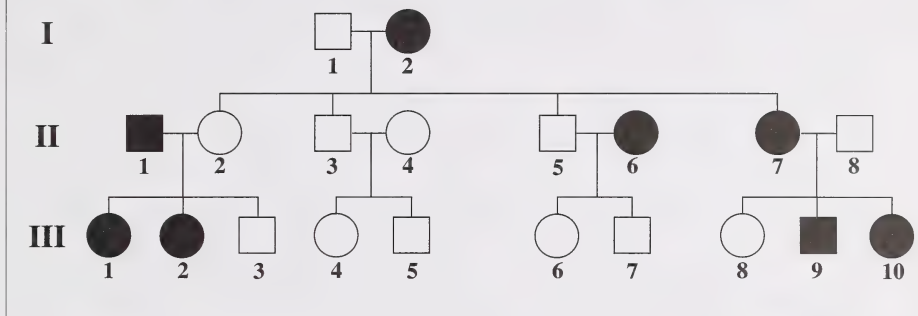
26. Individual **III-1** has blood type A. His genotype could be
- $I^A i \ Hb^A Hb^S$
 - $I^A I^A \ Hb^S Hb^S$
 - $I^A I^B \ Hb^A Hb^S$
 - $I^A I^A \ Hb^A Hb^A$
27. If individual **II-1** has blood type A and individual **II-2** has blood type B, which of the following genotypes would be possible for their third child, if they had one?
- $I^A i \ Hb^A Hb^S$
 - $I^A I^A \ Hb^S Hb^S$
 - $I^B I^B \ Hb^A Hb^S$
 - $I^A I^B \ Hb^A Hb^A$
28. Which of the following rows indicates the relationship between the I^A and I^B alleles and the relationship between the I^A and i alleles for the blood type gene?

Row	Relationship between I^A and I^B	Relationship between I^A and i
A.	codominant	codominant
B.	codominant	dominant-recessive
C.	dominant-recessive	codominant
D.	dominant-recessive	dominant-recessive

Use the following information to answer the next three questions.

A dominant allele, X^E , carried on the X chromosome causes the formation of faulty tooth enamel and causes either very thin or very hard enamel.

Hypothetical Pedigree Showing the Incidence of Faulty Tooth Enamel



29. The genotypes of individuals **II-6** and **III-7** are identified in row

Row	II-6	III-7
A.	$X^E X^E$	$X^E Y$
B.	$X^E X^e$	$X^e Y$
C.	$X^e X^e$	$X^E Y$
D.	$X^E X^E$	$X^e Y$

Numerical Response

4. A woman heterozygous for faulty tooth enamel marries a man with normal tooth enamel. What is the probability that their first child will be a boy with normal tooth enamel?

Answer: _____

(Record your answer as a value from 0 to 1, rounded to two decimal places, in the numerical-response section on the answer sheet.)

30. The faulty tooth enamel trait will appear in all of the daughters but none of the sons if the children have a father with
- A. normal tooth enamel and a mother with normal tooth enamel
 - B. normal tooth enamel and mother with faulty tooth enamel
 - C. faulty tooth enamel and a mother with normal tooth enamel
 - D. faulty tooth enamel and a mother with faulty tooth enamel

Use the following information to answer the next two questions.

Cross-over Frequencies of Some Genes on Human Chromosome 6

Genes	Approximate Cross-over Frequencies
Diabetes mellitus (1) and ovarian cancer (2)	21%
Diabetes mellitus (1) and Rhesus blood group (3)	12%
Ragweed sensitivity (4) and Rhesus blood group (3)	10.5%
Rhesus blood group (3) and ovarian cancer (2)	9%
Ragweed sensitivity (4) and ovarian cancer (2)	19.5%

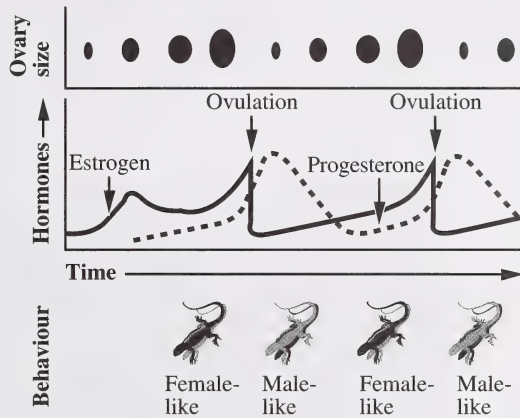
Numerical Response

5. On human chromosome 6, the order of the genes numbered above is _____, _____, _____, and _____.
- (Record your **four-digit answer** in the numerical-response section on the answer sheet.)
31. What is the approximate cross-over frequency between the diabetes mellitus gene and the ragweed sensitivity gene?
- A. 1.5%
 - B. 10.5%
 - C. 15.0%
 - D. 22.5%

Use the following information to answer the next three questions.

Desert-grassland whiptail lizards are all female, so they must reproduce by parthenogenesis. This is a type of reproduction in which females produce offspring from unfertilized eggs that have undergone chromosome doubling after meiosis. Although all whiptail lizards are females, they undergo courtship patterns similar to other types of lizards that have both sexes.

Sexual Behaviour in Parthenogenetic Lizards



—from Campbell, 1993

32. A correlation that can be made based on the data above is that
- A. male-like behaviour is correlated with relatively large ovaries
 - B. female-like behaviour is correlated with relatively small ovaries
 - C. male-like behaviour is correlated with high blood levels of estrogen
 - D. female-like behaviour is correlated with high blood levels of estrogen
33. A similarity between lizard reproductive hormones and human reproductive hormones is that
- A. after ovulation, ovaries decrease in size
 - B. before ovulation, ovaries increase in size
 - C. before ovulation, estrogen is secreted in decreasing amounts
 - D. after ovulation, progesterone is secreted in increasing amounts

34. According to the information on parthenogenetic lizards, the somatic cells of offspring produced from the whiptail lizard's unfertilized eggs would have a chromosome number of
- A. n
 - B. $2n$
 - C. $4n$
 - D. $n + 2$

Use the following information to answer the next four questions.



Elephants communicate mainly by means of infrasonic sound. This means that the sound is below the frequency of sound that a human can hear. Elephants also elicit a few higher-frequency trumpeting sounds that are audible to humans.

The infrasonic calls of elephants travel great distances. Researchers are now beginning to understand elephant behaviour based on this communication method. Certain calls are crucial in reproductive behaviour. The females use a distinctive infrasonic call when they are sexually receptive, which occurs for only four days every four years.

—from *The Edmonton Journal*, 1997

35. In the human ear, audible trumpeting sounds would be translated into nerve impulses in the
- A. ossicles
 - B. oval window
 - C. organ of Corti
 - D. semicircular canals

36. In comparison with humans, elephants would be considered
- A. *r*-selected, and they have a lower biotic potential than humans
 - B. *r*-selected, and they have a higher biotic potential than humans
 - C. K-selected, and they have a lower biotic potential than humans
 - D. K-selected, and they have a higher biotic potential than humans
37. Reproductive hormones function in a similar manner in elephants and in humans. The hormone change that stimulates ovulation every four years in female elephants is
- A. an increase in LH levels
 - B. a decrease in FSH levels
 - C. a decrease in estrogen levels
 - D. an increase in progesterone levels

Use the following additional information to answer the next question.

Some female mammals, such as humans and elephants, exhibit a variety of differences in their reproductive cycles.

Characteristics of Female Mammalian Reproductive Cycles

- 1 The cycle is called an estrous cycle.
- 2 The cycle is called a menstrual cycle.
- 3 The endometrium is shed if no pregnancy occurs.
- 4 The endometrium is absorbed if no pregnancy occurs.
- 5 There are pronounced behavioural changes around ovulation.
- 6 There are some behavioural changes throughout the cycle.

Numerical Response

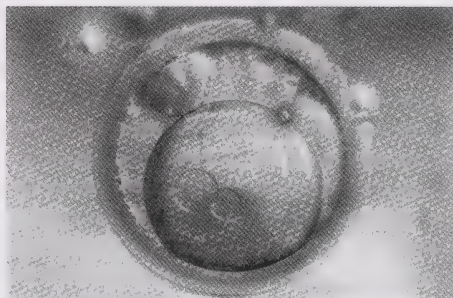
6. The three characteristics of most female elephants' reproductive cycles but **not** of most female humans' reproductive cycles are _____, _____, and _____.

(Record your **three-digit answer in lowest to highest numerical order** in the numerical-response section on the answer sheet.)

Use the following information to answer the next two questions.

Fertilization

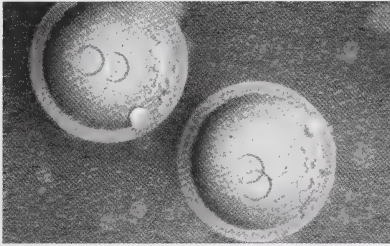
Fertilization occurs when a sperm fuses with an egg to form a zygote. In this diagram of a zygote, the sperm and egg nuclei are just fusing. (One polar body is also visible.)



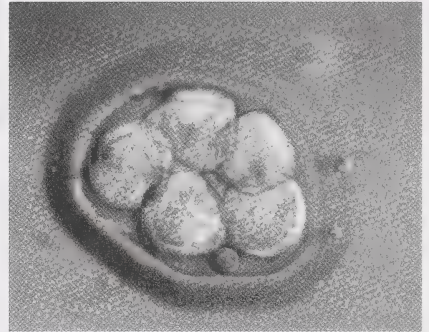
38. The event depicted above normally occurs in the
- A. ovary
 - B. uterus
 - C. vagina
 - D. Fallopian tube
39. The zygote shown above is composed of
- A. one diploid cell
 - B. two diploid cells
 - C. one monoploid (haploid) cell
 - D. one monoploid (haploid) and one diploid cell

Use the following information to answer the next two questions.

**Fertilized Human Eggs
(Two Zygotes)**



Eight-Cell Human Embryo



40. Which of the following statements **best** describes one of the diagrams above?
- A. The two zygotes will form identical twins.
 - B. The two zygotes are about to undergo meiosis.
 - C. The cells of the eight-cell human embryo have differentiated.
 - D. The cells of the eight-cell human embryo contain identical DNA.
41. The process that occurs to form an eight-cell embryo stage from a zygote is
- A. mitosis of diploid cells
 - B. mitosis of haploid cells
 - C. meiosis of diploid cells
 - D. meiosis of haploid cells

Use the following information to answer the next two questions.

Sam Wasser, a biologist, trains drug-sniffing dogs to locate feces of owls, wolves, and bears. The feces contain DNA that can be extracted and analyzed.

Researchers have used feces located by the dogs to obtain evidence to evaluate a wildlife management strategy that was being used by timber companies. The timber companies were feeding bears to discourage them from tearing bark off trees. Genetic analysis of their fecal matter indicated that the male bears were eating the food supplied and the female bears were eating bark from the trees.

—from *Simon*, 1997

42. One piece of evidence that the researchers used to determine that the timber companies' strategy was **not** working for all bears was that some of the feces contained
- A. bark chips and cells with two X chromosomes
 - B. bark chips and cells with one Y chromosome
 - C. food particles consistent with the food provided and cells with two X chromosomes
 - D. food particles consistent with the food provided and cells with one Y chromosome

Use the following additional information to answer the next question.

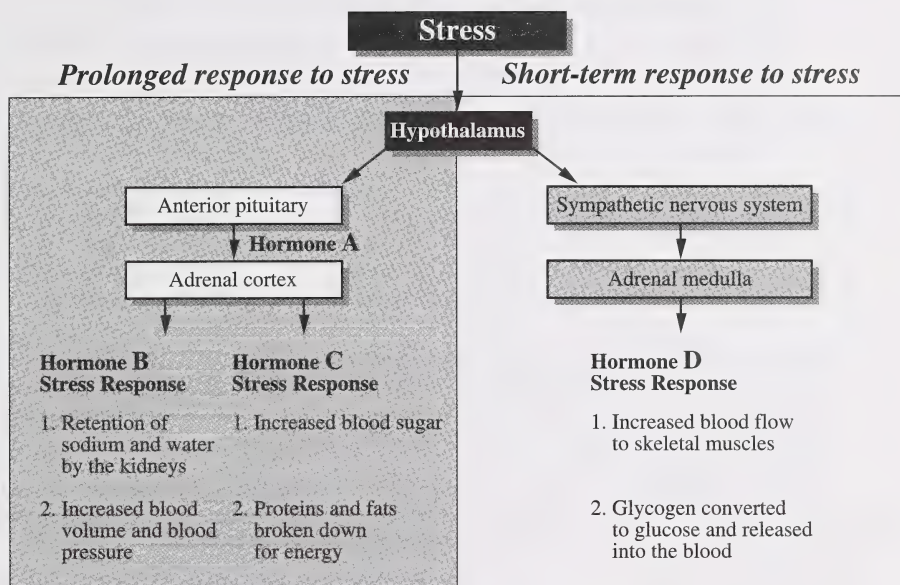
Biologists have been able to map the large territory inhabited by the bear population by locating their feces. In order to use DNA found in feces to track bears, it is necessary to identify individual bears by the DNA found in their feces. One technique that is used to do this is DNA fingerprinting.

43. In DNA fingerprinting, gel electrophoresis is used to
- A. cut DNA into fragments
 - B. separate fragments of DNA
 - C. match a gene with its function
 - D. pair homologous chromosomes

Use the following information to answer the next two questions.

Researchers analyzing spotted owl pellets found high levels of stress hormones in owls whose nests are within a quarter mile of logging areas. This information could be used to determine how large of a buffer zone is needed between the birds and the logging areas.

Animal Stress Response Flowchart



—from Simon, 1997

Use the following additional information to answer the next question.

Hormones Involved in an Owl's Stress Response That Could be Measured by Scientists

- 1 Cortisol
- 2 Aldosterone
- 3 ACTH
- 4 Epinephrine

Numerical Response

7. Match the hormones, as numbered above, to the letters A, B, C, and D in the flowchart above.

Hormone Number: _____
 Flowchart Letter: A B C D

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

44. In the owls, short-term response to stress occurs faster than prolonged response to stress because the
- A. blood from the adrenal medulla travels faster than does the blood from the adrenal cortex
 - B. adrenal medulla responds to nervous stimulation, which is faster than hormonal stimulation
 - C. adrenal medulla is controlled by the hypothalamus whereas the adrenal cortex is controlled by the pituitary
 - D. hormone from the adrenal medulla acts on cells more quickly than the hormones from the adrenal cortex

Use the following information to answer the next three questions.

The burrowing owl is an endangered species in Canada's western provinces. Research data collected in Saskatchewan's Burrowing Owl Recovery Project indicate that the population has declined by 20% per year over the past five years. In 1996, a population estimate showed that the number of burrowing owls had declined to 800 breeding pairs.

To obtain this population data, researchers reached into the burrows to collect and count baby owls. When they did this, the researchers heard a hiss like a rattlesnake coming from the baby owls in the burrow. The owls were attempting to scare off the intruders.

—from *The Globe and Mail*, 1997

45. The hissing behaviour of the baby owls is an example of

- A. mimicry
- B. mutualism
- C. camouflage
- D. commensalism

A Burrowing Owl



—from *Krasemann*, 1993

Numerical Response

8. If the decline of the burrowing owl population continued at the same rate, how many breeding pairs would there have been in 1998?

Answer: _____ breeding pairs

(Record your answer as a whole number in the numerical-response section on the answer sheet.)

Use the following additional information to answer the next question.

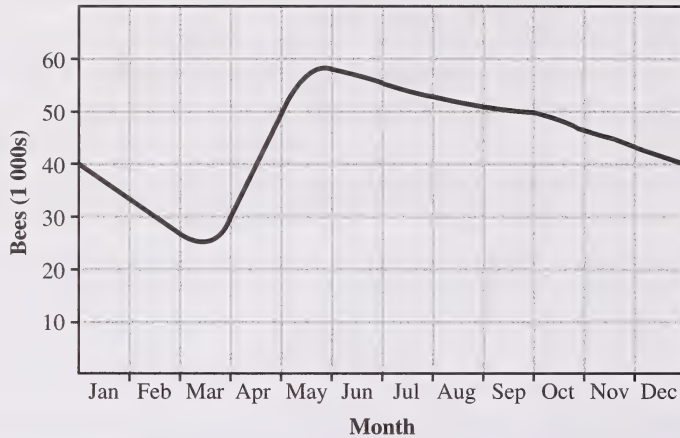
The burrowing owl habitat is open prairie grass. The owls live in ground squirrel holes that have been enlarged by badgers. The young owls are cared for by both parents who feed them a diet consisting of mice, moles, and insects. Other prairie predators such as the rattlesnake and kestrel (sparrow hawk) also rely upon these same food sources.

46. The relationship between the kestrel and the burrowing owl and the relationship between the burrowing owl and badger are given in row

Row	Kestrel/Burrowing Owl	Burrowing Owl/Badger
A.	predator–prey	mutualism
B.	predator–prey	commensalism
C.	interspecific competition	mutualism
D.	interspecific competition	commensalism

Use the following information to answer the next question.

The population of a colony of honey bees (*Apis mellifera*) in Alberta varies seasonally as illustrated in the following graph.



—from Bonney, 1993

47. The portion of the graph for April **most likely** indicates the effect of
- A. an increase in parasitism
 - B. a decrease in competition
 - C. a decrease in limiting factors
 - D. an increase in environmental resistance

Use the following information to answer the next question.

Mites (*Acarapis woodii*) can live in the trachea of a bee. These mites obtain nutrients from bee tissue. Beekeepers worry when mite populations reach numbers that have the potential to destroy the bee colony.

—from Bonney, 1993

48. The relationship between bees and mites is called
- A. parasitism
 - B. commensalism
 - C. interspecific competition
 - D. intraspecific competition

Use the following information to answer the next question.

Although doctors were astonished, relatives were not surprised when Benjy Stacy was born with skin the colour of a bruised plum. Two days of medical tests to rule out possible heart and lung disease revealed no cause for the newborn's dark blue skin. Not until Benjy's grandmother asked the puzzled doctors if they had ever heard of the blue Fugates of Troublesome Creek was the mystery solved. When baby Benjy inherited his mother's red hair and his father's lankiness, he also received his great-great-great-grandfather Martin Fugate's blue skin.

In 1820, a French orphan named Martin Fugate settled on the banks of Troublesome Creek. He and his red-headed American bride Elizabeth had seven children, four of which were reported to be blue-skinned. Isolated in the hills of eastern Kentucky, the family multiplied. Inter marriages between "blue Fugates" were common. Over time, the inherited blue trait began to disappear as the arrival of railways and roads allowed family members to marry outside their communities. Six generations after Martin Fugate first settled in Troublesome Creek, baby Benjy was born.

Based on Benjy's grandmother's account and further testing, doctors concluded that the newborn carried one copy of a mutated gene for methemoglobinemia. Hereditary methemoglobinemia is a rare autosomal recessive blood disorder. Blue people have an absence of the enzyme diaphorase in their red blood cells. In a normal individual, hemoglobin, the blood's red, oxygen-carrying molecule, is slowly converted to an non-functional blue form called methemoglobin. Diaphorase then converts methemoglobin back to hemoglobin. The absence of diaphorase in affected individuals is caused by a mutation in the enzyme's structural gene. This causes the accumulation of blue methemoglobin, which replaces the red hemoglobin responsible for pink skin in most Caucasians.

—from *Trost, 1982*

Written Response – 15%

Staple your word-processed response for **this** question to this page.

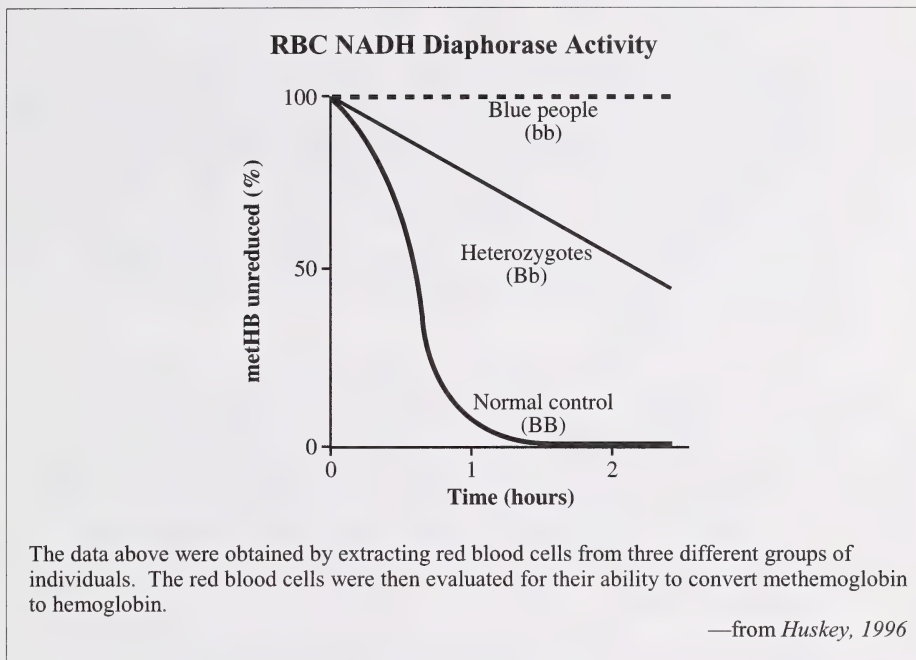
1. a. Explain how a gene mutation could alter the diaphorase enzyme's amino acid sequence. (2 marks)

Use the following additional information to answer the next three parts of the question.

In one account of the Fugate family's pedigree from 1750 to 1889, six of the 55 individuals expressed the blue phenotype as adults.

- b. Determine the frequency of the recessive allele for the Fugate family during this time. Show your work. **(2 marks)**
- c. Predict the theoretical percentage of individuals in the Fugate family that were heterozygotes during this time. Show your work. **(2 marks)**
- d. Explain why the frequency of the blue skin phenotype was higher in the Fugate family than in the general American population. **(1 mark)**
- e. Identify two ways in which the population, which consisted of six generations of the Fugate family, did not meet the conditions for Hardy–Weinberg equilibrium. **(2 marks)**

Use the following additional information to answer the next part of the question.



- f. Although he was very blue at birth, within his first few weeks, Benjy's skin colour changed to normal with no treatment required. At the age of seven, other than purplish blue lips when he was cold or angry, Benjy's colouration was normal.
- i. What is Benjy's genotype? **(1 mark)**
 - ii. Give a possible explanation for the change in Benjy's phenotype over time. **(1 mark)**
 - iii. Individuals with hereditary methemoglobinemia can be treated easily with methylene blue pills. Methylene blue acts as an "electron donor" converting methemoglobin to hemoglobin, which results in pink skin colouration. Explain why treated blue people can still produce offspring with hereditary methemoglobinemia. **(1 mark)**

Use the following information to answer the next question.

Development of a fetus in the uterus is of interest to both scientists and expectant parents. An embryo develops a neural tube (a fluid-filled structure that will later develop into a brain and a spinal cord) at five weeks and taste buds at 15 weeks. Fetuses have been known to show dream-like patterns through rapid eye movement (REM) at nine weeks. In the uterus, the fetus yawns and may experience taste and smell. The heart rate of a fetus decreases in response to its mother's voice. This suggests that the fetus somehow recognizes its mother's voice and is calmed by it. Even at birth, a baby already responds to and prefers its mother's voice. There is also evidence that stress in mothers increases cortisol levels and produces more active fetuses, and that more active fetuses are, in turn, more irritable infants. A baby's predisposition to certain tastes may be linked to what it was exposed to in the uterus. The amniotic fluid contains traces of chemicals from the foods the mother eats, and the fetus swallows amniotic fluids.

A study headed by pediatric neurologist Dr. Peter Hultenlocher has provided evidence that the majority of connections between neurons are made in the first three years of a child's life. The study indicates that a child's brain contains twice as many neurons and consumes twice as much energy as a normal adult brain. A study done at Baylor College of Medicine indicates that children who do not play or who are rarely touched by their mothers develop brains that are 20% to 30% smaller than normal for their age. Other studies show that in neural development from the fetal stage to ten years of age, connections between neurons develop as a result of the firing activity of neurons. Stimulation causes axons and dendrites to grow and produce synapses. If these connections are not reinforced by activity, they are eliminated from the brain's circuitry.

Studies of infants faced with emotional or physical trauma show that they also increase secretions of cortisol in response to stress. Cortisol has been shown to shrink regions of the brain involved in learning and memory. A newborn can also recognize and express emotion. Smiling mothers elicit a smiling, gurgling response in their babies. The infant's early response is linked to the social skill development needed for interpersonal relationships. The language spoken to a baby has been found to influence brain development. For example, babies spoken to in Japanese have different neural circuits than those spoken to in English.

Of the 100 000 human genes, 50 000 are dedicated to constructing and maintaining the nervous system. Some of these genes have been linked directly to learning. In fruit flies, a gene called CREB has been shown to increase its activity as a result of motor neuron stimulation. When this gene was inhibited in giant snails, their short-term memory developed but their long-term memory did not. The same gene is found in humans. Other genes may also be involved in learning.

—from Newberger, 1997
Nash, 1997
Hopson, 1998

Written Response – 15%

Staple your word-processed response for **this** question to this page.

2. Write a unified response addressing the following aspects of fetal development and development in early childhood.

- **Sketch** a diagram of the fetus and its environment at approximately three months development and **label** four structures that support the fetus in this environment. **Describe** how the environment in the uterus and structures associated with the fetus support the fetus during this stage of development.

- **Describe** the pathway for sensory interpretation in a fetus or newborn. Start from a **specific** stimulus to the part of the CNS that is stimulated in order for interpretation to occur.
- **Identify** and **describe** two technologies and/or government policies that might result in stimulation of appropriate neural development in children. **Explain** how each of these would affect neural development in early childhood.

Three-Month-Old Fetus and Associated Structures

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- WR2 Newberger, J.J. 1997. New brain development research—a wonderful window of opportunity to build public support for early childhood education. *Young Children*. May: 4–9.
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Credits

- MC13–15
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- MC24–25
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- WR1 Cathy Trost. From "The Blue People of Troublesome Creek" as found on <http://wsrv.clas.virginia.edu/~rjh9u/blkysc82.html>. Adapted and reprinted with permission from Cathy Trost.
- Diagram by Robert J. Huskey. From www.people.virginia.edu/~%7erjh9u/diaenz.html. Adapted and reprinted with permission from Robert J. Huskey, University of Virginia.

BIOLOGY DATA

Symbols

Symbol	Description
D_p	population density
N	numbers of individuals in a population
A	area, space, or volume occupied by a population
t	time
Δ	change
r	biotic potential OR maximum per capita population growth rate
K	carrying capacity
$\frac{\Delta N}{\Delta t}$	a change in population size during time interval
$>$	greater than, dominant over
$<$	less than, recessive to

Symbol	Description
σ	male
φ	female
n	chromosome number
B, b	alleles; upper case is dominant, lower case is recessive
I^A, I^B, i	alleles, human blood type (ABO)
P	parent generation
F_1, F_2	first, second filial (generation)
p	frequency of dominant allele
q	frequency of recessive allele

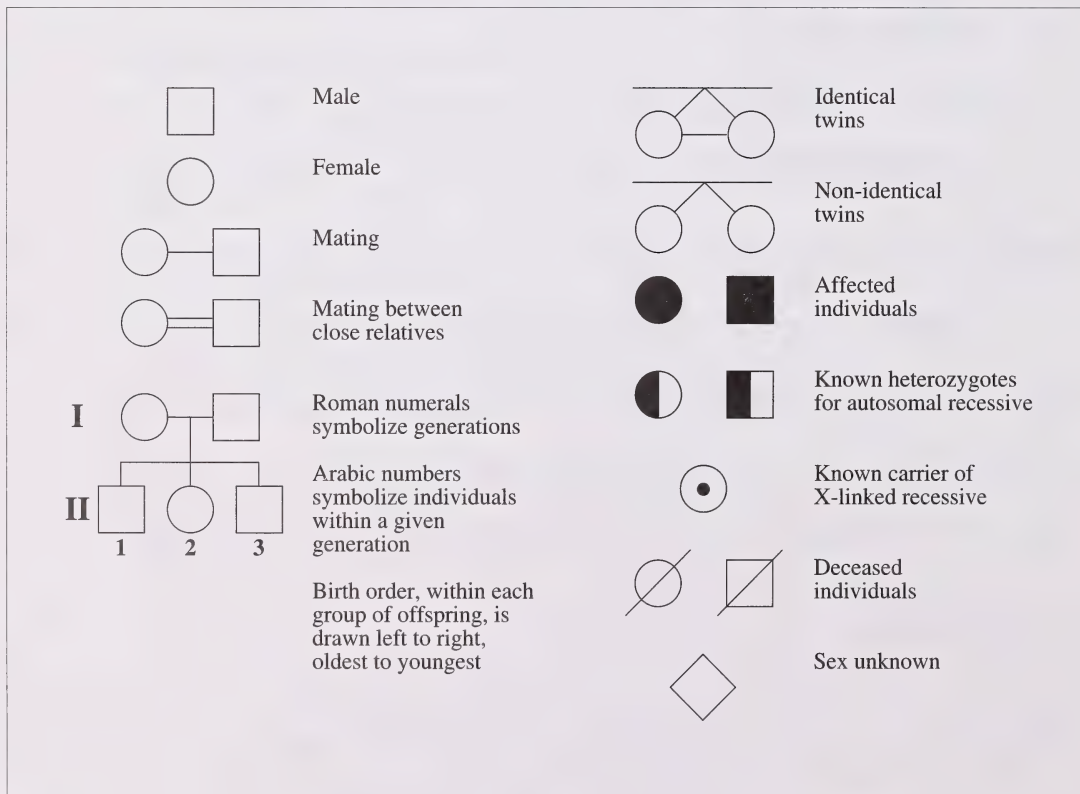
Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta N}{N}$
Growth rate	$\frac{\Delta N}{\Delta t} = rN$ $\frac{\Delta N}{\Delta t} = rN \frac{(K - N)}{K}$

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols



Messenger RNA Codons and Their Corresponding Amino Acids

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine*	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon and also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

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